

The Genus *Ceratopteris* In Malaya

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DEVOL (1957) HAS REPORTED confusion between the two species *Ceratopteris thalictroides* (L.) Brong. and *Ceratopteris pteridoides* (Hook.) Hieronymus in the identification of Asian material. Previously it was believed that *Ceratopteris pteridoides* occurred only in America, where it is found from 30°N to 27°S in wet tropical and sub-tropical habitats. DeVol found that plants previously collected from Central China, Tonkin, Annam, Cochin China and Cambodia are in fact *Ceratopteris pteridoides*.

Benedict (1909) used annulus characters to distinguish species of *Ceratopteris*. Other authors have assumed that *Ceratopteris pteridoides* could be separated from *Ceratopteris thalictroides* by its very poorly developed annulus consisting of a few cells only, without a stomium. While this is true for American plants, DeVol found that plants of both species collected from Eastern Asia all had a well-developed annulus. Therefore it seems that this character is unreliable, and *Ceratopteris pteridoides* is better distinguished by (i) habit of growth with floating, not emergent sterile leaves, (ii) sterile leaves deltoid, simple, not repeatedly pinnate, and (iii) stipe widest at base of lamina and tapering downwards.

Unfortunately these features can be only used for Malayan herbarium material in those specimens which have sterile leaves, or in which the whole stipe is in a good state of preservation. Fern collectors, aware of the importance of sporangial characters in other groups, have tended to collect fertile material only. Other features were sought to distinguish the wealth of isolated fertile leaves. By comparison of plants* which definitely fell into the *Ceratopteris pteridoides* group sensu DeVol by virtue of their sterile leaf-type with those which fell into the *Ceratopteris thalictroides* group, two distinguishing features were found which can be applied to fertile leaves or plants which have been collected in isolation.

*In addition to Malaysian material some South American plants were examined for purposes of comparison.

Key to Malayan species of *Ceratopteris*

1. Sterile leaves deltoid, usually simple with broad basal lobes.
Stipe broader above than below. Transitional leaves deeply pinnatifid. Fertile leaves very finely dissected, *ultimate segments webbed at their base, margin revolute only part-way to vein*. ***C. pteridoides***.
1. Sterile leaves pinnately divided. Stipe long and slender, usually broader below. Fertile leaves very finely dissected, ultimate lobes very slender and *not webbed at their base, margin revolute whole way to vein, all the lower surface being covered*. ***C. thalictroides***.

***Ceratopteris pteridoides* (Hook.) Hieronymus**, Bot. Jahrb. 34: 561. 1905.

Sterile fronds simple, often divided into two or three lobes. Stipe 1.5–5.5 cm. long, broadened above. Lamina broadly deltoid, 2.0–3.0 by 2.5–4.0 cm. *Transitional fronds* pinnatifid, with about five pinnae. Pinnae subdivided into broad ultimate lobes, 0.2–0.6 by 1–0–2.0 cm. Ultimate lobes usually webbed at base. *Fertile fronds* three to four times subdivided. Adventitious buds often present. Stipe very long, 9.0–25 cm. Seven to ten pinnae. Lamina oblong to long deltoid, about 15.0 by 18.0 cm. Ultimate lobes wide, about 1.6 by 0.4 cm. *distinctly webbed at the base. Margin revolute only part way to vein, leaving a central uncovered portion*. Sporangia in one row. Annulus distinct, many celled. Spores 32, hyaline coat with distinctive ridged pattern.

Penang: Prai, a weed of rice-land (Md. Nur Nos. 6230 and 6240).

Singapore: Seletar (Ridley); Ang Mo Kio (Ridley).

***Ceratopteris thalictroides* (L.) Brogn.**, Bull. Sci. Soc. Philom. 1821: 186.

Sterile fronds pinnatifid two to three times divided. Stipes 4.0–10.0 cm. long, commonly broadest at the base, ultimate segments, blunt, oblong or trapezoid to triangular about 0.6 by 0.4 cm. Frond oblong. *Transitional fronds* variously divided, stipe about 13 cm., usually broader at the base than above, at least part of the margin revolute but sporangia very few or absent. Pinnae usually about eight. *Fertile fronds* variously divided, stipe about 14 cm. long, often broader at base. Ultimate segments very numerous,

often flagelliform to about 4 cm. long and 0.2 cm. broad. Margin revolute, covering 1–2 rows of large yellow sporangia. *No webbing at base of ultimate lobes. Whole of lower surface covered by revolute margin.* Annulus distinct, many-celled. Spores 32 or 16 with distinctive ridged pattern.

Kedah: Langkawi (C. Curtis).

Kelantan: Gong Kedah (Symington 37948), Kamposa (Ridley).

Trengganu: Bukit Toh Beng (Md. Haniff 15337).

Province Wellesley: Tanjong Bunga (C. Curtis).

Perak: Sungei Krian Estate (Spare 1783), Thaipeng (Wray 689); no. loc. (Scortechini), Grik (Burkill & Md. Haniff 12550), Bota Kiri, near Ipoh (Md. Shah 255), Parit Buntar, Krian (A.O., Krian).

Selangor: Bukit Bintang (Goodenough).

Malacca: Gambega Batu (Hervey).

Pahang: Telok Sisek, Kuantan (Henderson 22756), Kuala Brawas (Ridley 1509).

Singapore: Changi (Ridley 4227).

Results on examination of Herbarium material

On examination of the twenty-one sheets of *Ceratopteris* from Malaya available in the Singapore Herbarium, it was found that only four of these were clearly *Ceratopteris pteridoides*. These plants had been collected in Penang and Singapore. They all showed sporangia with a many-celled annulus, but the stomium was not always very distinct. There were always 32 spores in the sporangia.

The other sheets mentioned above proved to be *Ceratopteris thalictroides*. The sporangia, in all cases, had a distinct many-celled annulus, the stomium was often distinct, but the number of spores was either 32 or 16. Specimens with only 16 spores came from Langkawi, Tanjong Bunga, Ipoh, Krian and Malacca. All other specimens had sporangia with 32 spores only. As Benedict (1909) has remarked, an accurate count of the number of spores is rendered difficult by the fragile nature of the sporangial wall. In all cases counts were made on previously unruptured sporangia, by transferring them first to a slide and rupturing under a cover glass. In some cases all the sporangia of a given frond were found to be dehiscent and a count was not possible. Records of 16 spores

in *Ceratopteris* are by no means unusual, in fact this number was recorded in Engler and Prantl's *Die Natürlichen Pflanzenfamilien*. However Benedict believes that this number is only found in the species he designates *C. deltoidea* Benedict, which falls in the *C. pteridoides* group sensu DeVol. However the Malayan specimens did not correspond to his species but were *Ceratopteris thalictroides*, their sterile leaves being oblong, not deltoid.

Examination of stipes

DeVol indicates that the kind of stipe is an useful feature in distinguishing *C. pteridoides* and *C. thalictroides*. In the former the stipe was broader above and tapering below, while in *C. thalictroides* the reverse was the case or the stipe was long and slender not tapering above. Examination of Malayan material indicated that while this feature was reliable for sterile and most transitional fronds it was not usable for fertile fronds. Measurements of the width of the stipe in sterile, transitional and fertile fronds were made at the base of the fronds and just below the point of emergence of the lowest part of the lamina. Ratios of:—

$$\frac{\text{width of stipe below}}{\text{width of stipe above}}$$
 were calculated.

In the sterile fronds of *C. pteridoides*, this ratio was always less than 1.0, varying from 0.45 to 0.90; while in *C. thalictroides* it varied from 1.66 to 2.50; that is the base of the stipe was approximately twice the width of the top of the stipe. In the transitional fronds of *Ceratopteris pteridoides* the ratio varied from 0.55 to unity, while in *C. thalictroides* it varied from 1.00–4.50. In fertile fronds of *C. pteridoides* it varied from 0.66 to unity, while in *C. thalictroides* it was unity or above to 5.0. Detailed results are given below with the standard errors of the mean values.

Means of ratios		$\frac{\text{width stipe below}}{\text{width stipe above}}$		
		Sterile frond	Transitional frond	Fertile frond
<i>C. pteridoides</i>	..	0.64 ± 0.08	0.69 ± 0.19	0.89 ± 0.03
<i>C. thalictroides</i>	..	2.05 ± 0.24	2.25 ± 0.43	1.66 ± 0.03

Within the population of *C. pteridoides* and *C. thalictroides* in Malaya there is a significant difference in the form of stipe, but for transitional fronds and fertile fronds in both species the ratio may approach unity in individual specimens.

Lengths of stipes

Measurements in cms. were made of the lengths of all complete stipes available. The results are given below.

		Sterile	Transitional	Fertile
<i>C. pteridoides</i>	..	1.9 \pm 0.03	5.7 \pm 0.55	18.4 \pm 3.69
<i>C. thalictroides</i>	..	7.4 \pm 0.97	13.4 \pm 0.90	14.07 \pm 1.02

The stipes of the sterile and transitional fronds of *C. pteridoides* were significantly shorter than those of *C. thalictroides*. The lengths of the stipes of the fertile fronds showed considerable variation in both species.

Ceratopteris thalictroides on Singapore Island

In 1959 Miss Elizabeth Periathamby* made a survey of the morphology, anatomy and distribution of water-ferns on Singapore Island. She found *Ceratopteris thalictroides* only at Yio Chu Kang and on the Jalan Tebal. She did not find *C. pteridoides* at any of the 318 ponds on Singapore Island which she visited.

The *Ceratopteris thalictroides* was found rooted along the margin and some distance inwards in *Eichornia crassipes* ponds and also in one fish-pond. Sterile fronds were in all cases pinnatifid with some of the pinnae lobed. The occurrence of buds was noted in the sinuses of the lobes and at the apices. Sterile fronds growing in pots of damp earth produced fronds which were not always pinnatifid, some were irregularly lobed and some linear. Such strange fronds were never observed under field conditions.

The fertile fronds also produced adventitious buds covered by a small scale. Sterile fronds were formed on burying these fronds in soil.

*Contribution to the Morphology, Anatomy and Distribution of the Water-Ferns in Singapore. Thesis B.Sc. (Honours) 1959.

All specimens of *Ceratopteris* collected in recent years in Singapore Island by the author have proved to be *C. thalictroides*, not *C. pteridoides*.

Conclusion

Ceratopteris pteridoides and *C. thalictroides* both occur in Malaya but the former has only been found in Penang and Singapore. While it is easiest to distinguish the two species on their habit and shape of sterile leaves, it is possible to distinguish fertile leaves by webbing at the base of the ultimate lobes, and by the degree of revolution of the margin. In Malayan specimens of *C. pteridoides* the annulus is distinct and many-celled, but the stomium may be absent. The number of spores was always 32. In *C. thalictroides* there was a many-celled annulus often with a distinct stomium. The number of spores may be 16 or 32.

The width of the stipe above and below was only a reliable feature for sterile and transitional fronds. The lengths of these stipes was significantly shorter in *C. pteridoides*.

References

- Benedict, R. C. (1909) . . . The genus *Ceratopteris*: a preliminary revision. Bull. Torrey. Bot. Club 36, 463-476.
- DeVol, Charles E. (1957) . . The geographical distribution of *Ceratopteris pteridoides*. American Fern Journal, 47, 67-72.

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